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# STX13004

## High voltage fast-switching NPN power transistor

### Features

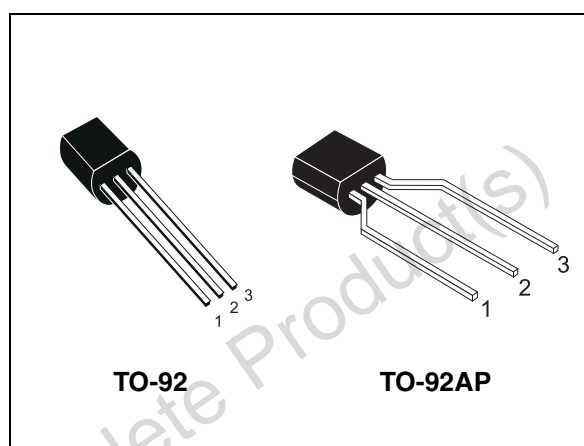
- High voltage capability
- Low spread of dynamic parameters
- Minimum lot-to-lot spread for reliable operation
- Very high switching speed

### Application

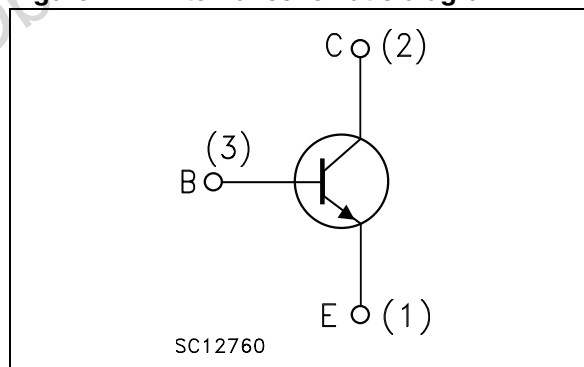
- SMPS for battery charger

### Description

The device is manufactured using high voltage multi epitaxial planar technology for high switching speeds and high voltage capability. It uses a cellular emitter structure with planar edge termination to enhance switching speeds while maintaining the wide RBSOA.



**Figure 1. Internal schematic diagram**



**Table 1. Device summary**

| Order codes                 | Marking | Package | Packaging |
|-----------------------------|---------|---------|-----------|
| STX13004                    | X13004  | TO-92   | Bulk      |
| STX13004G <sup>(1)</sup>    | X13004G | TO-92   | Bulk      |
| STX13004-AP                 | X13004  | TO-92AP | Ammopack  |
| STX13004G-AP <sup>(1)</sup> | X13004G | TO-92AP | Ammopack  |

1. The letter "G" in the order code identifies the product as ECOPACK@2 grade. Please see [Section 3](#) for details.

Electrical ratings

STX13004

# 1 Electrical ratings

**Table 2. Absolute maximum ratings**

| Symbol    | Parameter  | Value         | Unit |
|-----------|--|---------------|------|
| $V_{CES}$ | Collector-emitter voltage ( $V_{BE} = 0$ )                                 | 700           | V    |
| $V_{CEO}$ | Collector-emitter voltage ( $I_B = 0$ )                                    | 400           | V    |
| $V_{EBO}$ | Collector-base voltage ( $I_C = 0, I_B = 1\text{ A}, t_P < 10\text{ ms}$ ) | $V_{(BR)EBO}$ | V    |
| $I_C$     | Collector current  | 2             | A    |
| $I_{CM}$  | Collector peak current ( $t_P < 5\text{ ms}$ )                             | 4             | A    |
| $I_B$     | Base current   | 1             | A    |
| $I_{BM}$  | Base peak current ( $t_P < 5\text{ ms}$ )                                  | 2             | A    |
| $P_{TOT}$ | Total dissipation at $T_C = 25\text{ °C}$                                  | 2.5           | W    |
| $T_{STG}$ | Storage temperature  | -65 to 150    | °C   |
| $T_J$     | Max. operating junction temperature  | 150           |      |

**Table 3. Thermal data**

| Symbol     | Parameter                               | Value | Unit |
|------------|---|-------|------|
| $R_{thJC}$ | Thermal resistance junction-case max    | 50    | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient max | 150   | °C/W |

**STX13004**
**Electrical characteristics**

## 2 Electrical characteristics

 $T_{\text{case}} = 25\text{ }^{\circ}\text{C}$ ; unless otherwise specified.

**Table 4. Electrical characteristics**

| Symbol                           | Parameter  | Test conditions  | Min. | Typ. | Max. | Unit          |
|----------------------------------|--|--|------|------|------|---------------|
| $I_{\text{CES}}$                 | Collector cut-off current<br>( $V_{\text{BE}} = 0$ )           | $V_{\text{CE}} = 700\text{ V}$   |      |      | 10   | $\mu\text{A}$ |
| $I_{\text{CEO}}$                 | Collector cut-off current<br>( $I_{\text{B}} = 0$ )            | $V_{\text{CE}} = 400\text{ V}$   |      |      | 1    | mA            |
| $V_{(\text{BR})\text{EBO}}$      | Emitter-base breakdown<br>voltage ( $I_{\text{C}} = 0$ )       | $I_{\text{E}} = 10\text{ mA}$  | 9    |      | 18   | V             |
| $V_{\text{CEO(sus)}}^{(1)}$      | Collector-emitter sustaining<br>voltage ( $I_{\text{B}} = 0$ ) | $I_{\text{C}} = 10\text{ mA}$  | 400  |      |      | V             |
| $V_{\text{CE(sat)}}^{(1)}$       | Collector-emitter saturation<br>voltage                        | $I_{\text{C}} = 1\text{ A}$ $I_{\text{B}} = 200\text{ mA}$   |      |      | 0.5  | V             |
|                                  |  | $I_{\text{C}} = 2\text{ A}$ $I_{\text{B}} = 500\text{ mA}$   |      |      | 1    | V             |
| $V_{\text{BE(sat)}}^{(1)}$       | Base-emitter saturation<br>voltage                             | $I_{\text{C}} = 1\text{ A}$ $I_{\text{B}} = 200\text{ mA}$   |      |      | 1.2  | V             |
|                                  |  | $I_{\text{C}} = 2\text{ A}$ $I_{\text{B}} = 500\text{ mA}$   |      |      | 1.6  | V             |
| $h_{\text{FE}}$                  | DC current gain  | $I_{\text{C}} = 0.5\text{ mA}$ $V_{\text{CE}} = 2\text{ V}$  | 15   | 35   |      |               |
|                                  |  | $I_{\text{C}} = 400\text{ mA}$ $V_{\text{CE}} = 2\text{ V}$  | 26   |      |      |               |
|                                  |  | $I_{\text{C}} = 1\text{ A}$ $V_{\text{CE}} = 5\text{ V}$   | 10   |      | 30   |               |
|                                  |  | $I_{\text{C}} = 2\text{ A}$ $V_{\text{CE}} = 5\text{ V}$   | 6    |      | 16   |               |
| $t_{\text{s}}$<br>$t_{\text{f}}$ | Resistive load<br>Storage time                                 | $I_{\text{C}} = 2\text{ A}$ $t_{\text{p}} = 30\text{ }\mu\text{s}$<br>$I_{\text{B(on)}} = -I_{\text{B(off)}} = 400\text{ mA}$          |      | 1.1  |      | $\mu\text{s}$ |
|                                  | Fall time  | $V_{\text{CC}} = 125\text{ V}$ $V_{\text{BB(off)}} = -5\text{ V}$<br>(see <a href="#">Figure 12</a> )                                  |      | 300  |      | ns            |
| $t_{\text{s}}$<br>$t_{\text{f}}$ | Inductive load<br>Storage time                                 | $I_{\text{C}} = 1\text{ A}$ $V_{\text{clamp}} = 300\text{ V}$<br>$I_{\text{B(on)}} = 250\text{ mA}$ $V_{\text{BB(off)}} = -5\text{ V}$ |      | 2.4  |      | $\mu\text{s}$ |
|                                  | Fall time  | $C_{\text{snooper}} = 1\text{ nF}$ $R_{\text{BB(off)}} = 0$<br>(see <a href="#">Figure 13</a> )  |      | 200  |      | ns            |

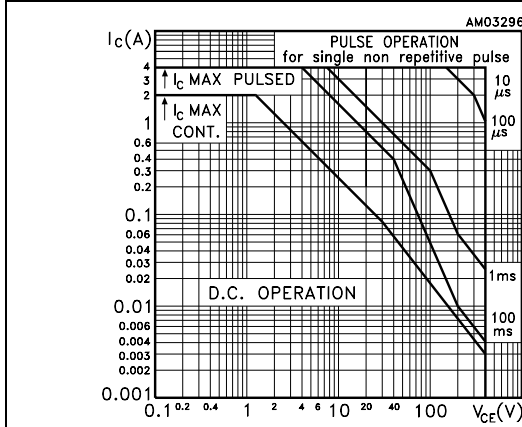
 1. Pulse test: pulse duration  $\leq 300\text{ }\mu\text{s}$ , duty cycle  $\leq 2\%$ .

**Electrical characteristics**

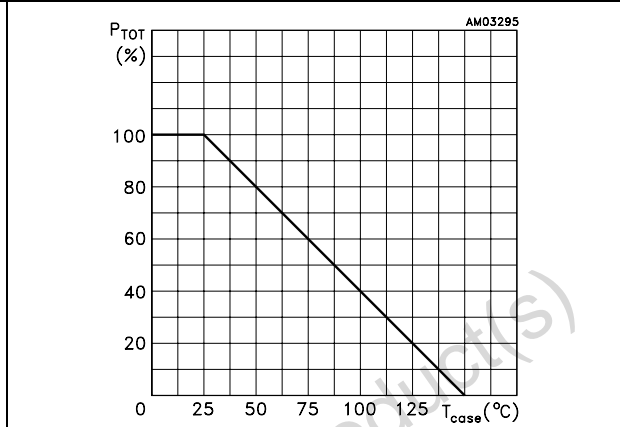
**STX13004**

**2.1 Electrical characteristics (curves)**

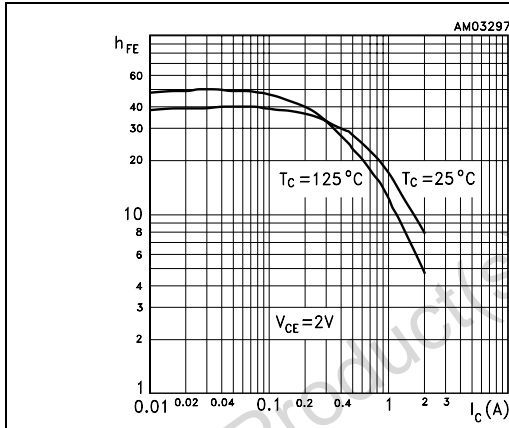
**Figure 2. Safe operating area**



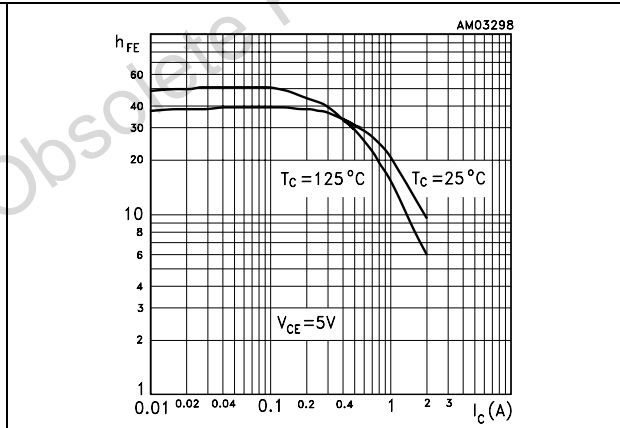
**Figure 3. Derating curve**



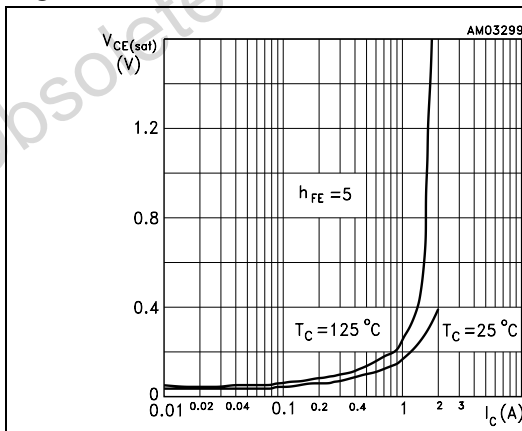
**Figure 4. DC current gain @ V<sub>CE</sub> = 2 V**



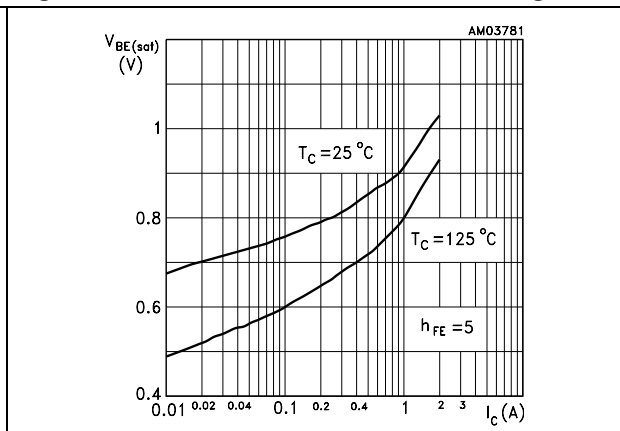
**Figure 5. DC current gain @ V<sub>CE</sub> = 5 V**



**Figure 6. Collector-emitter saturation voltage**



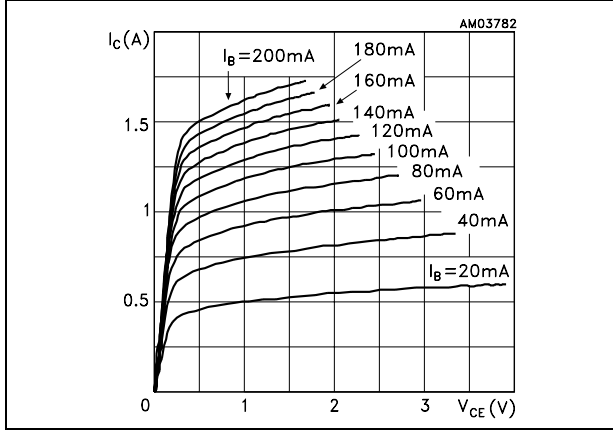
**Figure 7. Base-emitter saturation voltage**



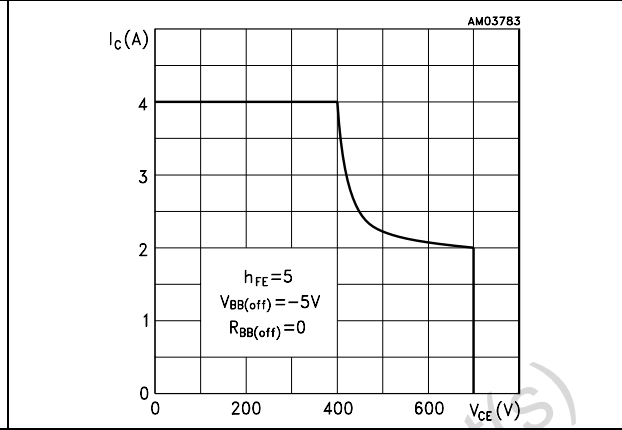
**STX13004**

**Electrical characteristics**

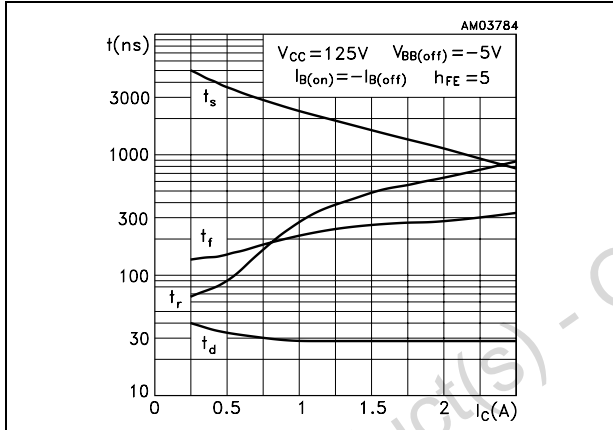
**Figure 8. Output characteristics**



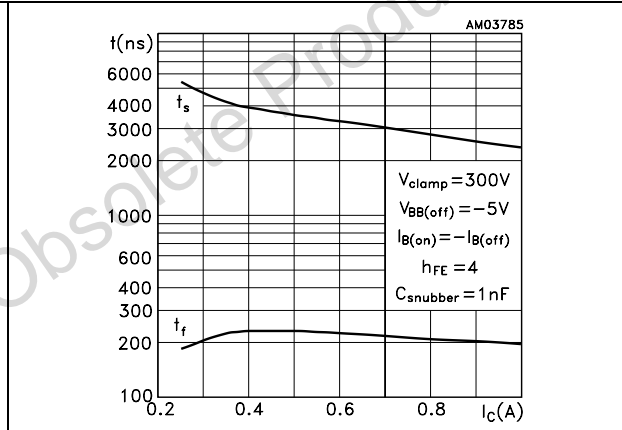
**Figure 9. Reverse biased SOA**



**Figure 10. Resistive load switching times**

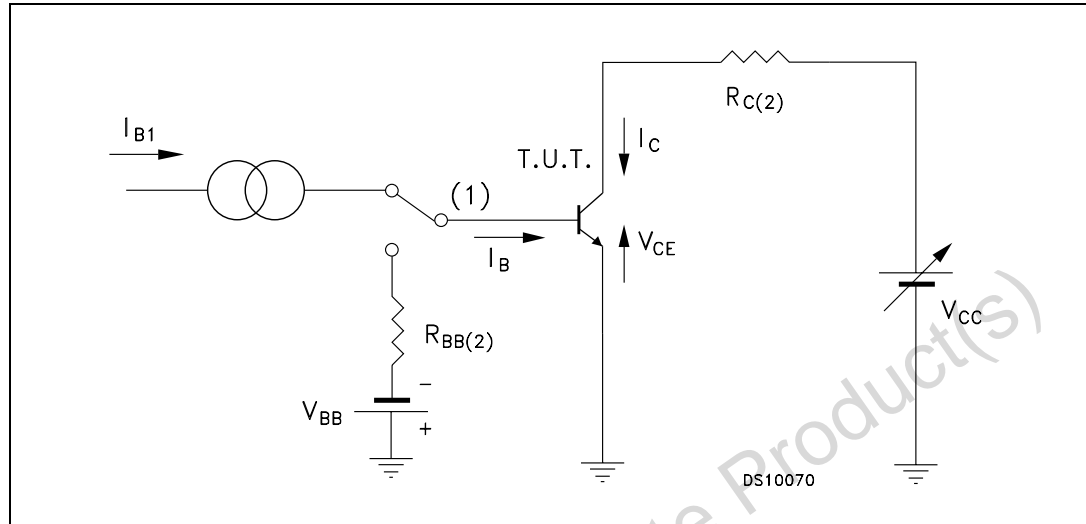


**Figure 11. Inductive load switching times**



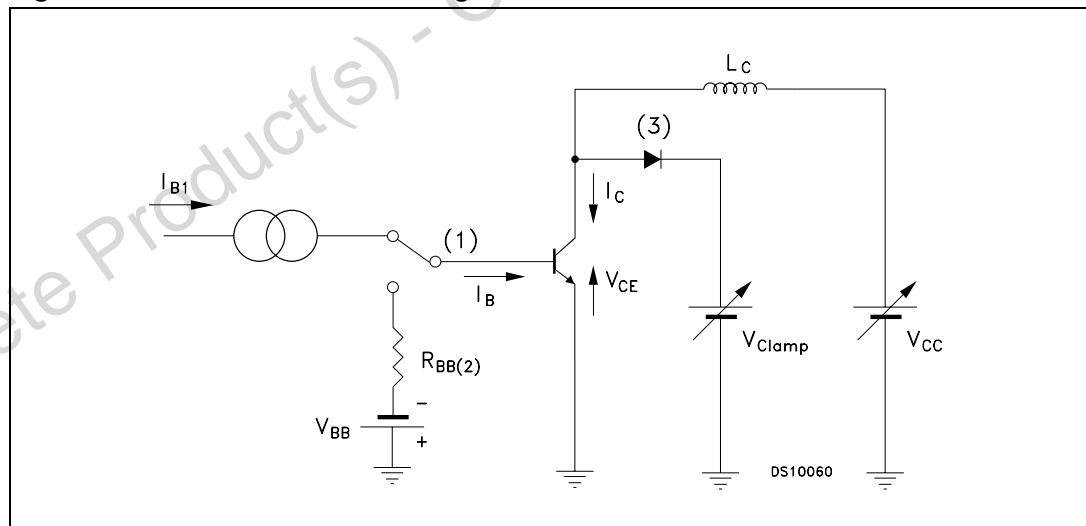
## 2.2 Test circuits

**Figure 12. Resistive load switching test circuit**



1. Fast electronic switch
2. Non-inductive resistor

**Figure 13. Inductive load switching test circuit**



1. Fast electronic switch
2. Non-inductive resistor
3. Fast recovery rectifier

### 3 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

Obsolete Product(s) - Obsolete Product(s)

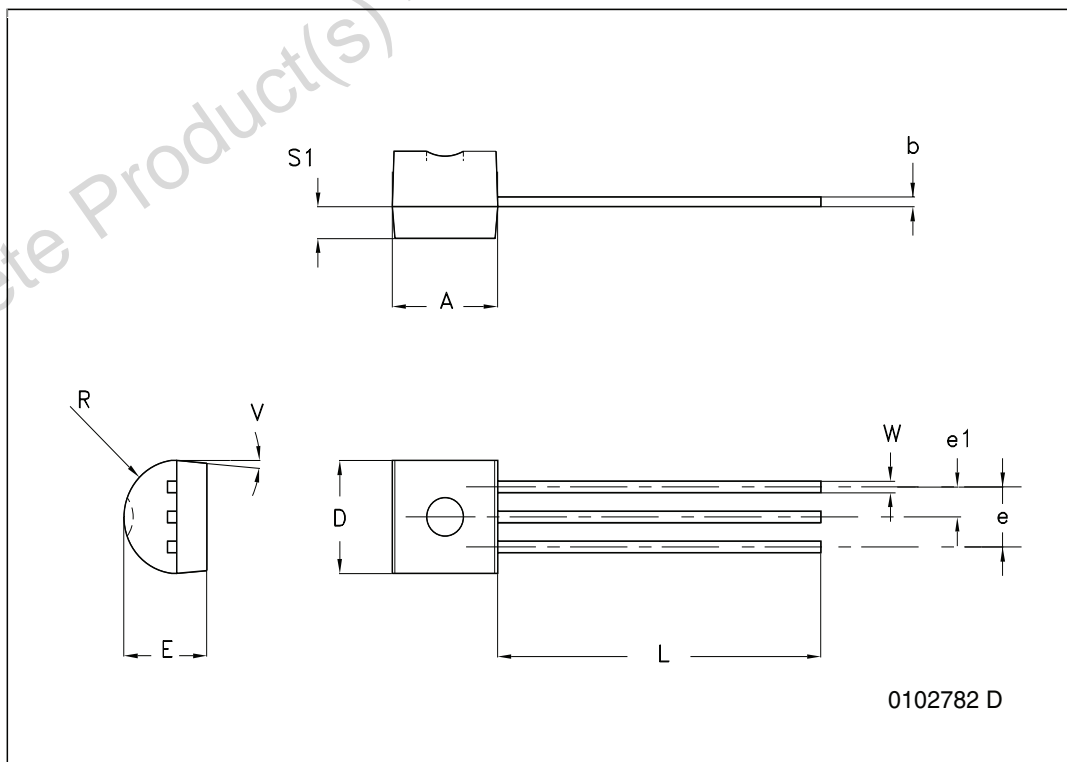


**Package mechanical data**

**STX13004**

**TO-92 bulk shipment mechanical data**

| DIM. | mm.   |     |       |
|------|-------|-----|-------|
|      | MIN.  | TYP | MAX.  |
| A    | 4.32  |     | 4.95  |
| b    | 0.36  |     | 0.51  |
| D    | 4.45  |     | 4.95  |
| E    | 3.30  |     | 3.94  |
| e    | 2.41  |     | 2.67  |
| e1   | 1.14  |     | 1.40  |
| L    | 12.70 |     | 15.49 |
| R    | 2.16  |     | 2.41  |
| S1   | 0.92  |     | 1.52  |
| W    | 0.41  |     | 0.56  |
| V    |       | 5°  |       |

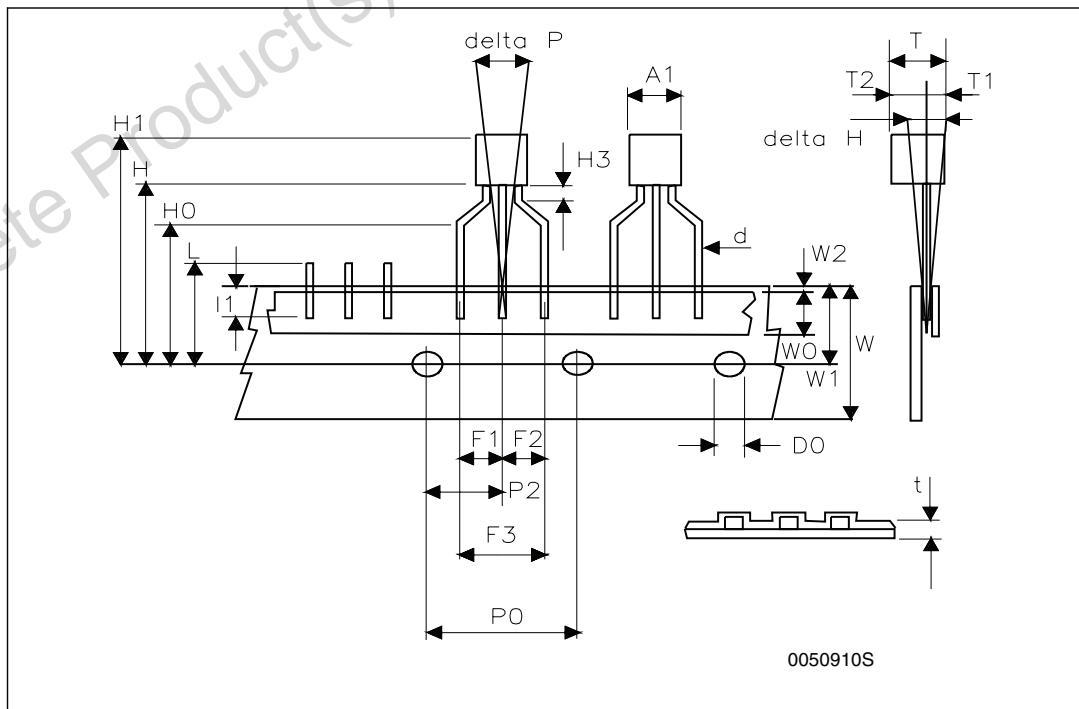


**STX13004**

**Package mechanical data**

**TO-92 ammpack shipment (suffix"-AP") mechanical data**

| Dim.    | mm    |       |       |
|---------|-------|-------|-------|
|         | Min   | Typ   | Max   |
| A1      |       |       | 4.80  |
| T       |       |       | 3.80  |
| T1      |       |       | 1.60  |
| T2      |       |       | 2.30  |
| d       |       |       | 0.48  |
| P0      | 12.50 | 12.70 | 12.90 |
| P2      | 5.65  | 6.35  | 7.05  |
| F1,F2   | 2.44  | 2.54  | 2.94  |
| F3      | 4.98  | 5.08  | 5.48  |
| delta H | -2.00 |       | 2.00  |
| W       | 17.50 | 18.00 | 19.00 |
| W0      | 5.70  | 6.00  | 6.30  |
| W1      | 8.50  | 9.00  | 9.25  |
| W2      |       |       | 0.50  |
| H       | 18.50 |       | 20.50 |
| H3      | 0.5   | 1     | 1.5   |
| H0      | 15.50 | 16.00 | 16.50 |
| H1      |       |       | 25.00 |
| D0      | 3.80  | 4.00  | 4.20  |
| t       |       |       | 0.90  |
| L       |       |       | 11.00 |
| l1      | 3.00  |       |       |
| delta P | -1.00 |       | 1.00  |



## 4 Revision history

**Table 5. Document revision history**

| Date        | Revision | Changes  |
|-------------|----------|--|
| 01-Apr-2009 | 1        | First release.   |
| 21-Apr-2010 | 2        | Updated $h_{FE}$ specification <a href="#">Table 4 on page 3</a> .   |
| 06-Jul-2010 | 3        | Added $R_{thJA}$ value <a href="#">Table 3 on page 2</a> and updated $I_{CES}$ maximum value <a href="#">Table 4 on page 3</a> . |

Obsolete Product(s) - Obsolete Product(s)

## STX13004

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